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REVIEW COMMENTS ON THE PHASE II
REMEDIAL INVESTIGATION SAMPLING PLAN

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT

TETRA TECH, INC.
FOR
JACOBS ENGINEERING GROUP, INC.
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TETRA TECH COMMENTS ON THE U S. DOE ROCKY FLATS PLANT
PHASE II REMEDIAL INVESTIGATION SAMPLING PLAN
903 PAD, MOUND, AND EAST TRENCHES AREAS
GOLDEN, COLORADO
FOR THE U S ENVIRONMENTAL PROTECTION AGENCY REGION VIII

GENERAL SUMMARY

Volumes I and II of the Phase II Remedial Investigation (RI) plan for the 903 Pad, Mound, and East Trenches areas at the U.S. Department of Energy's (DOE) Rocky Flats Plant in Golden, CO were reviewed for compliance with the requirements of applicable federal regulations and overall adequacy in filling the data gaps identified following review and evaluation of the Phase I RI sampling effort.

Review of the Phase II RI plan was complicated by the uncertainties that exist regarding specific sampling methods to be employed in the proposed field effort. References are made in the Phase II RI plan to the Comprehensive Environmental Assessment and Restoration Program (CEARP) generic monitoring plan, the installation generic monitoring plan, and site-specific monitoring plans/remedial investigation plans. However, all of these documents were not available for review. Review of all available documents (i.e., site-specific monitoring plan, project operations plan for geological and hydrological site characterization) failed to provide the level of detail necessary to ascertain the specific methods that would be used to collect samples, or the rationale for selecting soil sampling horizons in the field. In the Phase I RI document, the only mention of sampling horizons for soil contamination data is in the narrative provided in Chapter 4.0 (Waste Sources Characterization), and this discussion only mentions sampling depths for a limited number of samples. The data presented in Volume IX of the Phase I RI document does not facilitate interpretation of subsurface sampling horizons from sample numbers. The lack of sufficient information on sampling horizons and deficient rationale

for selecting subsurface sampling horizons is also found in the Phase II RI plan, making an accurate assessment of the proposed sampling approach very difficult

The Phase II RI plan also states that "a CEARP Phase 2 preliminary remedial investigation report has been completed for all other priority sites (903 Pad, Mound, East Trenches areas), and a CEARP Phase 3 feasibility study is in progress at these sites " According to the definition provided in the introductory sections of the document, the Phase II effort completes the evaluation of potential environmental concerns. The RI program to-date has been remiss in providing any basic information on the sources of the contamination. It is difficult to envision the facility beginning to formulate plans for developing remedial alternatives and undertaking remedial actions when information has not been provided on the nature of the contamination within the various solid waste management units (SWMUs) themselves. There seems to be an underlying assumption that the sources of the contamination should and will be addressed by the remedial action program, but no clear indication is given as to how this effort will be coordinated with remediation of the releases that have already occurred from the SWMUs.

The descriptions of the SWMUs provided in the Resource Conservation and Recovery Act (RCRA) Part B operating permit application also fail to provide the required information necessary to conduct an adequate evaluation of remedial alternatives (e.g., complete contaminant identification, contaminant concentrations, areal extent of sources of contamination, depth of contamination). Facility representatives have stated that specific source characterization will not be undertaken due to potential health and equipment contamination concerns. Sufficient information has not been presented by the facility representatives to justify this position. Based on the chemical and radiological materials currently documented as being present at the site, these concerns are unjustified. However, if the data exists to substantiate these concerns the means of circumventing an adequate source characterization should be discussed to aid in evaluating the adequacy of the remaining portions of the CEARP Phase II program.

The final general area of concern in reviewing the facility's approach to the Phase II RI sampling effort is the adequacy of the data obtained during the Phase I sampling effort. The preliminary Phase I document did not provide specific information on the sampling methods that were employed and, as indicated previously, provided little information on the selection of sampling horizons. The standard operating procedures provided in the project operations plan (Rockwell International 1986) indicate that sampling of drill cuttings is an acceptable method for subsurface soil sampling. However, this is not acceptable in this situation because volatile organic compounds are one of the major contaminants of concern at the Rocky Flats site. Use of this method of sampling may account for the exceptionally large composite intervals described for the surface sampling horizon (e.g., 0-10 ft). A primary concern is that "maximum contaminant levels" are compared to health and technology based criteria several times in the document. The comparisons are subsequently used to determine whether or not further investigative efforts are warranted. It is not clear at this time whether or not the maximum soil contaminant levels have been identified, especially in light of the paucity of data provided regarding the contaminant sources. More information regarding the selection of sampling horizons and sampling methods would clarify the adequacy of the available data in meeting the objective of identifying maximum soil contaminant levels.

SECTION 2 0 PHASE I SITE EVALUATION

This section of the Phase II RI plan presents the site-specific model that has been developed to describe the pathways through which contaminant transport may occur from the various areas of contamination addressed in this sampling phase. Several inconsistencies were noted in the site-specific model during the Phase II sampling plan review. In general, the development of the site-specific model was not conservative in approach. Specific comments are presented below.

A number of times in this section the statement is made that radionuclide contamination at several of the sites in the vicinity of the 903 drum storage site is the result of wind dissemination. It is difficult to evaluate this conclusion given the large vertical intervals sampled during the Phase I borehole sampling effort.

The plan states on page 2-28 that the source of low level organic contamination at Well 17-87 may be Trench T-1, which is located "adjacent to" Well 17-87. A review of the figures provided with the Phase II document indicates that Well 17-87 is located approximately 150-200 ft from the trench.

The basis for the maximum travel distance cited on page 2-30 should be provided to aid in defining optimal locations for the monitoring wells. The conceptual model utilizes mean hydraulic conductivity values to calculate "maximum" flow velocities (page 2-8). These flow velocities should be presented as mean flow velocities. The maximum expected groundwater flow velocities should be presented to aid in evaluating the potential distribution of contaminated groundwater discharge to surface water bodies and other factors relevant to Phase II sampling.

Section 2 3 of the Phase II RI plan deals with compliance of applicable or relevant and appropriate requirements (ARARs). Table 2-3 of the plan

lists all chemicals found to exceed their associated ARARs, and is used to identify analytical parameters for Phase II of the RI. Due to the standard quality and quantity of existing information, limiting analytical parameters based on a comparison with ARARs is inappropriate. Analytical parameters should be selected based on known waste constituents, accurate definition of background concentrations, and health-based criteria developed specifically for this site.

Table 2-3 also draws conclusions about whether individual requirements or standards are applicable, relevant, and appropriate, or are to be considered. There are several mistakes or misinterpretations present in the table. For example, information provided in Table 2-3 states that because groundwater at the site is not classified, the Colorado Department of Health's agricultural and human health groundwater standards are not ARAR. The unclassified status of the groundwater may mean that these standards are not applicable, but because of the farming and cattle operations present downgradient of the site, the standards are definitely relevant and appropriate. Table 2-3 also identifies Safe Drinking Water Act maximum contaminant levels (MCLs) as being relevant and appropriate, when in fact they should also be considered applicable because both South Walnut and Wonnar Creek discharge into drinking water reservoirs, and the alluvial groundwater system is directly connected with these creeks.

CHAPTER 3 0 DATA QUALITY OBJECTIVES

Chapter 3 of the Phase II RI plan outlines the data quality objectives (DQOs) for the remainder of the RI. Six broad DQOs for the RI are listed that cover the necessary needs of any RI. At this stage of the 903 Pad, Mound, and East Trenches areas RI, the DQOs should be clearly defined.

The first three DQOs (page 3-1) relate to the characterization of waste sources, the nature and extent of contamination, and migration pathways. Specific objectives relating to these goals that should be included in the Phase II RI plan are:

- Identification of MCLs in all media (e.g., wastes, soil, groundwater)
- Determination of horizontal and vertical extent of contamination at the sources and the resultant contaminant migration
- Definition of groundwater and surface water interaction
- Definition of the interaction between the alluvial and bedrock groundwater systems
- Identification and characterization of potential light- and dense-phase contaminant layers
- Definition of both physical and chemical transport characteristics for all contaminants.

The fourth DQO, determination of public exposure health risks, is only appropriate if the data generated by the RI are considered acceptable. Specifically, precise determination of background and maximum contaminant

concentrations is critical for an accurate determination of exposure potential and health risks

The fifth DQO, assessing compliance with ARARs, is self explanatory. However, as previously discussed, it is important to correctly define requirements and standards as applicable, or relevant and appropriate.

The sixth DQO, satisfying data requirements for selecting remedial alternatives, is important for satisfactorily completing the RI/feasibility study (FS) process. A corollary objective of defining the data requirements for remedial alternative selection should also be included in the Phase II RI plan. The technologies and remedial strategies currently under consideration should be presented together with the associated data requirements. It is critical that a clear statement of the data required for the FS be made, before well installation and sampling efforts begin.

Chapter 3 presents a comparison of chemical-specific ARARs and the associated detection limits (see Table 3-3 in the Phase II RI plan). Four of the compounds listed, including tetrachloroethene and trans-1,2-dichloroethene, have analytical detection limits above the ARAR levels. For this phase of the RI, this should not present a problem, because most of the levels that are expected to be encountered should be significantly above the associated detection limits. However, during subsequent phases of the RI/FS (e.g., meeting cleanup criteria), precise determinations of the chemical concentrations will be required. Analytical methods are available that provide detection limits below ARAR levels.

On page 3-4 of the Phase II RI plan, the following statements are made: "With the exception of the 903 Pad, sufficient data already exists for characterization of waste sources. These wastes are mixed hazardous and radioactive waste whose composition and volumes are adequately defined." Data have not been presented that characterizes waste sources beyond what disposal areas were used and when, and a rough estimation of the type of wastes disposed of. Such limited information is inadequate for the purposes of waste characterization. Information on the current condition of all the facility's waste sources may be provided in a 1 June 1988 document entitled

"Remedial Investigation/Feasibility Study for Low Priority Sites" currently under review by U.S EPA Region VIII. If this document does not contain current source information, then it must be provided from another source so that an adequate review of the proposed sampling efforts can be made.

CHAPTER 4 0 PHASE II SAMPLING LOCATIONS AND RATIONALE

This section provides specific comments on Chapter 4 0 of the Phase II RI plan, and general comments regarding the hydrogeologic characterization of the 903 Pad, Mound, and East Trenches areas. Data gaps and areas of concern identified during review of the Phase I RI report are described briefly to provide a basis for developing an effective sampling approach for the remainder of the RI process

Five major data gaps and areas of concern have been identified by the review team in the site conceptual model developed following the Phase I RI sampling effort. These data gaps include:

- Characterization of waste sources
- Definition of the nature and extent of contamination (e.g., plume definition)
- Development of an accurate hydrogeologic model for the site
- Identification and definition of the transport characteristics of the contaminants and potential migration pathways
- Development of a consistent sampling strategy for the remainder of the RI process that identifies specific goals and the approach used to meet these goals.

The sampling approach proposed in the Phase II RI plan was reviewed taking into account these data gaps, and recommendations were made so that the Phase II field effort will provide the type and quality of data needed to begin the FS.

GENERAL COMMENTS

The most critical concern with the sampling approach presented in Chapter 4.0 is the attempt to limit further sampling based on the results of previous investigations. Data presented up to this point in the RI have not adequately defined sources, characterized the nature and extent of contamination, nor described the hydrogeological characteristics of the site. Limiting the scope of further investigations based on these incomplete data will result in the design and selection of remedial alternatives that will neither be effective in cleaning up the site nor protective of human health and the environment.

Another related concern is the use of the health- and technology-based criteria presented in Table 4-4 (page 4-6) to evaluate whether or not further soil characterization is needed. These criteria are used to justify essentially no further soil characterization. Of particular concern are the technology-based criteria listed in Table 4-4. These criteria, derived from RCRA land disposal restrictions (LDR), are inappropriate for use in defining which areas need additional sampling, or for establishing cleanup levels following a release of contaminants. The RCRA LDR criteria are designed to identify whether or not wastes are acceptable for disposal in suitably engineered and permitted hazardous waste landfills, not for application to, or comparison with, environmental contaminant levels. Representative background contaminant levels should be used as criteria for deciding which areas warrant further sampling.

The comparison of existing soils data to these technology-based criteria is misleading. Table 4-4 lists the "maximum" concentration in the soil for each contaminant, when in fact maximum contaminant concentrations may not have been identified. Zones with maximum contaminant concentrations (hot spots) will most likely be found within or directly beneath the SWMUs. Because the vast majority of soil samples have been collected from areas adjacent to, or in the proximity of the SWMUs, and because contaminants are not expected to migrate laterally in unsaturated soils, the existing data do not represent the maximum contaminant concentrations found at the site.

Furthermore, the existing analytical data are of questionable validity, and decisions based on this data are similarly suspect

The origins of the health criteria presented in Table 4-4 are also unclear, and may not be protective of human health. These criteria were developed in the risk assessment performed during the 881 Hillside FS. This risk assessment was reviewed by Tetra Tech (1988b) and several major flaws were noted including:

- Inadequate background data were available and the available data were misinterpreted, undermining the usefulness of the estimate of human health risks
- Inadequate characterization of source areas may have led to grossly underestimating MCLs and the associated health risks.

The risk assessment for the 881 Hillside area does not develop criteria for all the compounds found at the 903 Pad, Mound, and East Trenches areas. For example, no health-based criteria are presented for acetone, methylene chloride, methyl ethyl ketone, toluene, 1,1,1-trichloroethane, xylene, and ethyl benzene. Radionuclides and metals criteria (health or technology based) are not presented. The Phase II RI plan compares individual compounds with individual criteria when in fact many of the contaminants may have additive health effects. All compounds with risks based on carcinogenic potency factors should be studied as a group instead of individually. Noncarcinogenic health effects should also be investigated. Because groundwater and surface water are the primary migration pathways of concern, health-based criteria for waterborne contaminants should be developed. It is suggested that Table 4-4 be deleted from the sampling plan until both background levels and maximum contaminant concentrations in source areas are accurately determined. Use of Table 4-4, in its present condition, to determine data needs is misleading and may not result in appropriate site characterization or cleanup levels which are protective of human health or the environment.

The rationale for well placement and the sampling approach presented in Chapter 4.0 are either lacking in detail, based on misleading assumptions, or do not take into account all pertinent factors. For example:

- The Phase II RI plan does not appear to take into account the reported large downward-directed vertical hydraulic gradients when addressing contaminant transport and well placement. Similarly, the chemical and physical characteristics of the contaminants (e.g., density, solubility, adsorption characteristics) have not been considered in the design of the monitoring program.
- The geophysical survey mentioned on page 4-23 needs to be described in more detail. Previous geophysical survey results should be referenced. The techniques proposed for the survey should be defined, and the objectives of the geophysical survey should be clearly stated.
- The Phase II RI plan does not describe the laboratory testing of geologic core samples that will be conducted. These tests are performed to provide additional information on soil composition, permeabilities, and grain size distributions. Methods should be referenced for all proposed tests.

PROPOSED SITE CHARACTERIZATION AND SAMPLING STRATEGY

The following sections discuss the methods proposed in the Phase II RI plan to characterize the site hydrogeology, and define the nature and extent of contamination.

Borehole Placement

The Phase II RI plan proposes drilling several boreholes in addition to the monitoring wells that will be installed during Phase II of the RI. Boreholes are apparently to be used for defining the nature of the organic contamination in the soil in the 903 Pad and the Mound areas. Some of the

boreholes will be completed as alluvial monitoring wells. Information is not provided in the Phase II RI plan for the boreholes that will not be completed as wells, for anticipated borehole completion depths, rationale for selection of sampling horizons, and the methods selected for sampling and abandoning the boreholes (grouting).

Source Characterization

Source characterization is one of the major objectives of any RI program. The ensuing FS effort is based on an accurate definition of the nature and extent of contamination, especially in areas with high levels of contamination (i.e., SWMUs). The Phase I RI investigation for the 903 Pad, Mound, and East Trenches areas was fundamentally lacking in adequate source characterization (Tetra Tech 1988a). The sampling strategy proposed in the Phase II RI plan addresses some of the deficiencies noted in the Phase I RI report, but major problems with source definition and characterization still exist.

It was strongly recommended that boreholes and wells be installed within SWMUs to define the maximum concentration of contamination existing at the site. Wells or boreholes are proposed for installation within source areas in only two cases (two proposed boreholes in the Mound area and several wells at the reactive metal destruction site). The reasons given in the Phase II RI plan for not conducting intrusive sampling of other source areas include potential health risks during drilling, potential sampling equipment and drill rig contamination problems, and the "extensive measures" required to control dissemination of plutonium-contaminated soils. These reasons require further clarification, and are discussed below.

On page 4-1, the Phase II RI plan states that for organic compounds, "Soil contaminant concentrations at the 903 Pad, Mound, and East Trenches areas never exceed . . . health based criteria". It is also stated in the report numerous times that radionuclide contamination is limited to surface soils. These two statements do not support the conclusion that it is too dangerous to drill in source areas. The potential health risks need to be detailed on an individual basis for each SWMU. Specific contaminant levels

and other hazardous conditions must be presented for each location. Generalized statements concerning all source areas are not acceptable for Phase II RI purposes.

The claim that equipment and drill rig contamination precludes drilling in all source areas is not valid. For a project of this size, sampling equipment and a portable drill rig can be dedicated to the project and, if necessary, any contaminated equipment can be disposed of after project completion. This approach has been used at other DOE site investigations. Since characterization of source areas should only require shallow borings (e.g., 15-20 ft maximum depth), use of a relatively inexpensive truck-mounted auger should be adequate.

The claim that "extensive measures" will be required to control dissemination of plutonium-contaminated soils is not valid. If radionuclide contamination is limited to the surface, then it should be relatively easy to clear an area large enough to drill through. If dusty conditions are encountered, then water or suppressant foam could be used judiciously at the surface to control contaminant dispersion. Boreholes can be abandoned safely without enhancing contaminant migration by the use of pressure grouting techniques.

To summarize, characterization of the source areas is a critical step in the RI/FS process. Without adequate data defining the maximum concentration of contaminants in soil, subsoil, and groundwater, selection of appropriate and effective remedial measures is not possible. The Phase II RI plan does not present compelling reasons for not drilling within the SWMUs, and without further detailed information the reasons presented are not valid.

Monitoring Well Program - General Comments

The number of wells needed to adequately monitor any given site is dependent upon several factors including the size of the site, nature of contaminants, and the hydrogeology of the site. Unfortunately, for the 903 Pad, Mound, and East Trenches areas, these factors all work against the

implementation of simple monitoring system. The site is large (approximately 250 ac), contains at least 16 different potential sources, involves contaminants that are both lighter and denser than water, and is located in an area with a complex hydrogeology (e g , downward vertical gradients, multiple groundwater flow directions).

Despite the complexities of the site, an adequate monitoring and characterization program must be conducted as part of the RI. The program proposed for Phase II of the RI is deficient in several critical areas, and will not provide the data necessary to progress into the FS. Areas that need to be incorporated into the design of the monitoring system include:

- The transport characteristics, both physical and chemical, of the contaminants must be considered when designing wells. For example, wells must be screened at the section of the aquifer where contaminants are most likely to be found. If lighter phase contaminants are present, wells should be screened to include the water table. If denser phase contaminants are present, wells should be screened at the bottom of the saturated zone being evaluated.
- Seasonal variations in site hydrology, including water levels and flow directions, must be evaluated with respect to well placement. For example, because well installations may occur during the dry season (late fall and winter), the water table may be considerably lower than at other times of the year. Wells may need to be screened several feet above the water table elevation during such periods.
- The compatibility of contaminants with well construction materials must be considered. Polyvinyl chloride, the proposed well construction material, is incompatible with esters, ketones, and aromatic hydrocarbons (U.S. EPA 1986). Phthalates (both an ester and an aromatic hydrocarbon), acetone (a ketone), and xylene (an aromatic hydrocarbon) have all been detected in the soil and groundwater at the site.

The influence of these compounds on well construction materials, and related effects on analytical data should be evaluated

- Wells or piezometers should be placed at appropriate intervals to generate piezometric surface maps. There are several substantial gaps in the proposed monitoring system, specifically in the areas north of the Mound area and east of the reactive metal destruction site.
- Screened intervals greater than 5-10 ft in length are generally not acceptable for monitoring purposes. Wells should be screened at the water table when light phase contamination is suspected and at the alluvium/bedrock contact when dense phase contaminants are present. At Rocky Flats, both light and dense phases are present, which warrants the installation of well clusters or multiport well systems. Under no circumstances is a 30 or 40 ft screened interval acceptable for groundwater monitoring purposes. Water level data from wells with large screened intervals are unsuitable for the construction of potentiometric surface plots in areas with vertical gradients such as the Rocky Flats site.

Alluvial Well Placement

The Phase II RI plan proposes 49 additional wells to monitor the alluvial aquifer in the 903 Pad, Mound, and East Trenches areas (Figure 1). The discussion below focuses on the proposed locations of the monitoring wells, and on recommendations concerning changes and additions to the proposed well installations. Potential problems concerning screen placement and well construction materials were addressed in the previous section. Unless specifically mentioned below, the proposed well locations in the Phase II RI plan are acceptable for Phase II of the RI.

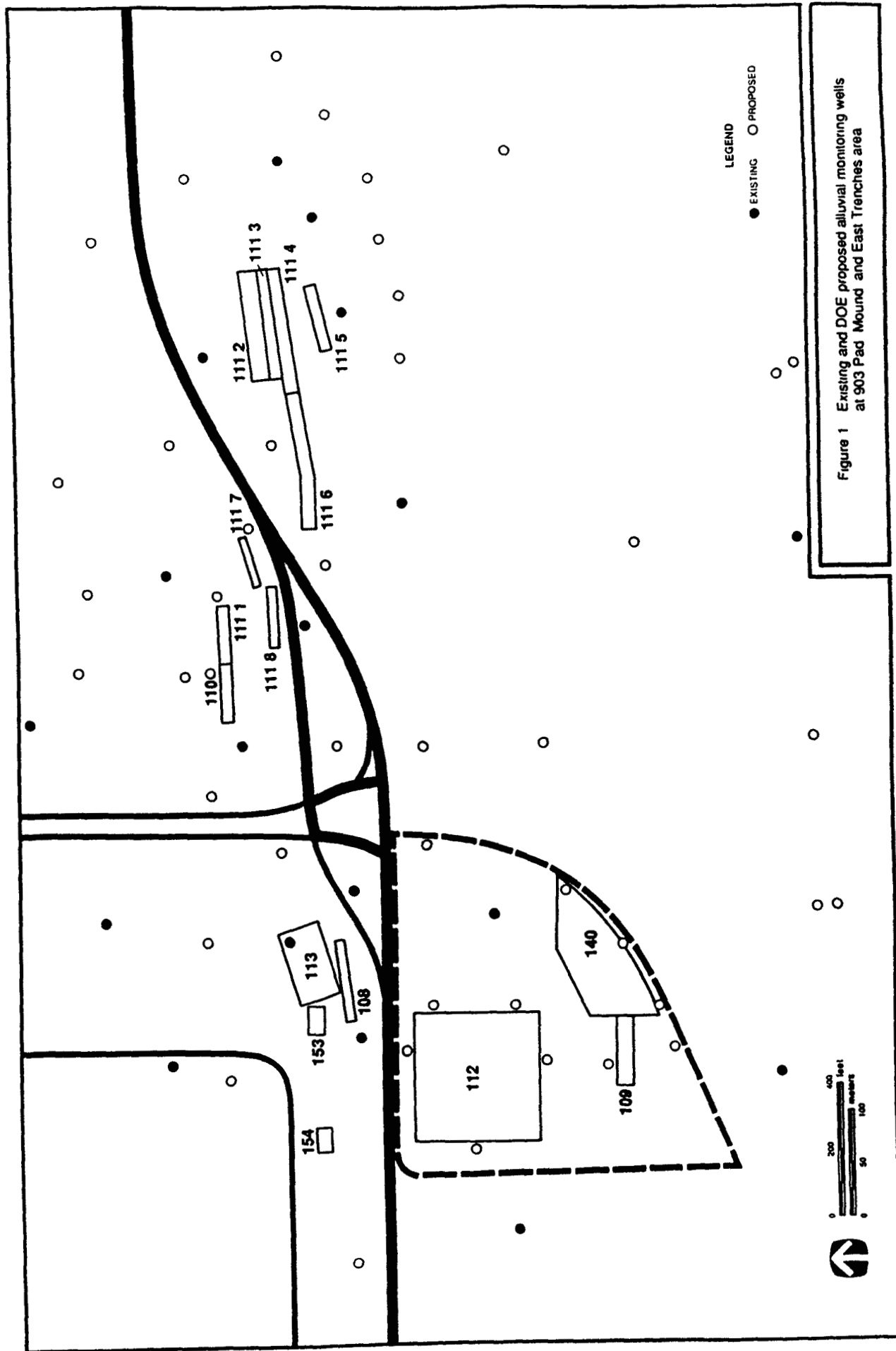


Figure 1 Existing and DOE proposed alluvial monitoring wells at 903 Pad Mound and East Trenches area

It is recommended that several of the proposed alluvial monitoring wells be relocated to provide better data for source characterization and plume definition, in addition to providing usable potentiometric data for the site (Figure 2). The recommended relocations and rationale for each move are described as follows:

- Well 8-88 -- Move 175 ft west. The new location will provide water quality data immediately downgradient of the 903 Pad area.
- Well 45-88 -- Move approximately 150 ft south. The new location is closer to potential sources in the East Trenches area, and will provide data on the nature of contaminants being discharged from these SWMUs. The original location was more than 450 ft downgradient of Well 35-87, the well closest to Trench T-4 (too large of a gap).
- Well 52-88 -- Move 75 ft southwest (near borehole 46-87). The new location will provide downgradient water quality information for Trench T-11. The proposed location appears to be cross-gradient to the trench.
- Well 43-88 -- Move 150 ft southwest and install a well cluster at this location (see below). The recommended location is closer to Trenches T-3 and T-4, and is centrally located between Wells 79-88 and 36-86.

The majority of alluvial wells proposed in the Phase II RI plan are located to provide adequate plume definition data. While this is necessary and will serve to meet nature and extent DQOs, additional source characterization data are needed to begin meaningful technology screening for the FS. As previously discussed, if boreholes and monitoring wells cannot (or will not) be installed in the source areas themselves (e.g., through the trenches), then wells immediately adjacent to, and downgradient from, the sources must be installed.

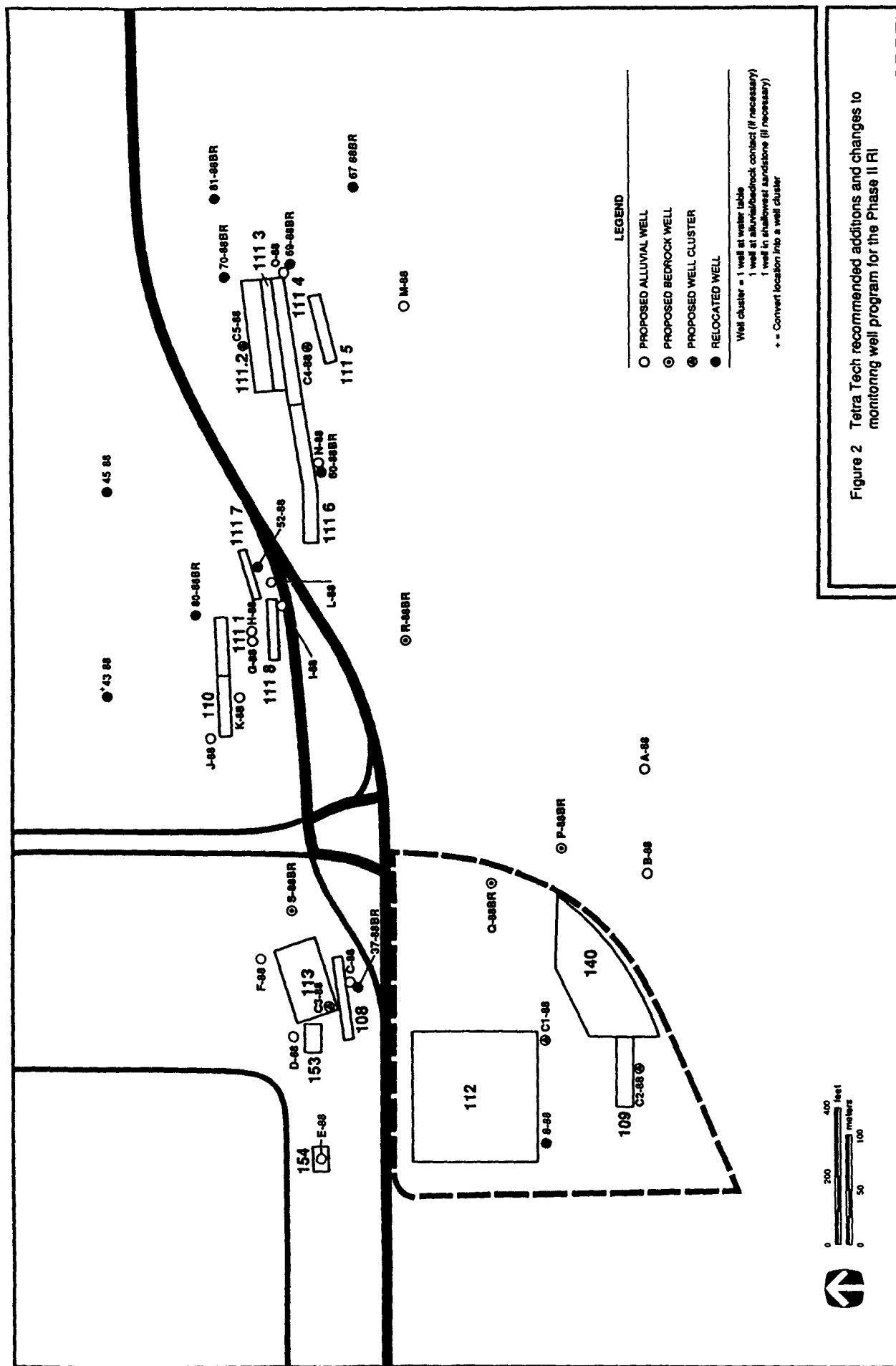


Figure 2 Tetra Tech recommended additions and changes to monitoring well program for the Phase II RI

The following paragraphs discuss recommended additions to the alluvial monitoring system. In general, these additions focus on acquiring source data as well as obtaining vertical hydraulic gradient data that are crucial for evaluating contaminant transport. The recommendations below are based on hydrogeologic data and sampling results provided in the Phase I RI report (Rockwell International 1987), and in the Phase II RI plan. If information not contained in these documents has a bearing on the recommendations, then it should be provided, referenced, and alternative approaches presented.

Well clusters are proposed at several strategic locations. The well clusters will provide information needed to define contaminant levels near sources, and critical hydrogeologic data. The proposed clusters are comprised of up to three separate wells located in close proximity to each other (e.g., within 10-15 ft). It is recommended that one of the wells in the cluster be screened at the water table in the alluvium, the second well screened at the alluvium/bedrock contact (i.e., in the weathered bedrock), and the third well screened in the sandstone bed encountered below the alluvium/bedrock contact. Specific sandstone layers that should be monitored are recommended below. The wells should be oriented so that the alluvial well is closest to SWMU, with the alluvium/bedrock contact well located downgradient of the alluvial well, and the bedrock well located just downgradient of the alluvium/bedrock contact well. This arrangement follows likely contaminant migration pathways, and will minimize the influence of the grout and seals used to construct deep wells on the water quality in nearby shallower wells, while providing data on vertical hydraulic gradients between and within formations. If the weathered bedrock zone is thin (less than 5 ft), then one screened interval could be used to monitor both the weathered bedrock and the sandstone zones. Similarly, if the water table and the alluvium/bedrock contact are close to each other (within 5-10 ft), then a single screen could be used to cover both zones.

These clusters would serve two very important purposes. First, because the clusters are located very near contaminant sources or potential "hot spots", they will provide data indicative of contaminant levels in the groundwater system adjacent to the disposal area and information on how contaminant levels vary with depth. Second, the cluster approach will

provide valuable information on vertical hydraulic gradients beneath the sources. This information is critical to an evaluation of contaminant migration pathways and remedial alternatives.

Recommended additions and associated rationale for the placement of monitoring wells or clusters (see Figure 2) are as follows:

903 Pad Area--

- Cluster C1-88 -- A well cluster should be located immediately adjacent to, and 50 ft west of, the southeast corner of the 903 Pad area. This cluster location is downgradient of the center of the 903 Pad area and will provide critical hydrogeologic and source characterization data. The bedrock well should be completed in sandstone X or Y.
- Cluster C2-88 -- This cluster, located next to Borehole 25-87, will establish the downgradient groundwater quality immediately adjacent to Trench T-2. Currently, the nearest existing, or proposed downgradient well is 125 ft away (Well 12-88). This cluster will help to establish the extent to which vertical migration occurs at the source. The bedrock well should be completed in sandstone X or Y.
- Well A-88 -- Located 300 ft south-southwest of Well 31-88, this alluvial well will help fill a substantial gap downgradient of the 903 Pad area (see Figure 1). Currently, there are no existing or proposed alluvial wells downgradient of Wells 14-88 and 15-88 for at least 900 ft.
- Well B-88 -- Located 250 ft due east of Well 14-88. This well will help fill a substantial gap downgradient of the 903 Pad area (see Figure 1). Currently, there are no existing or proposed alluvial wells downgradient of Wells 14-88 and 15-88 for at least 900 ft.

Mound Area--

- Cluster C3-88 -- Located 100-200 ft west of Borehole 36-87. This cluster should be installed within the Mound area (SWMU 113, see Well 19-87) to provide source characterization and vertical migration data. There are no existing or proposed wells presently located in this area. The perimeter security fence and some buried utilities are located in this area. A review of as-built drawings, and a geophysical survey may be required to locate buried utilities or other structures prior to drilling. The bedrock well should be completed in sandstone X.
- Well C-88 -- Located next to Well 37-88BR (also proposed for relocation) to monitor alluvial groundwater quality downgradient of Trench T-1 and the Mound area. Currently, there are no proposed alluvial wells in this area. By locating this well next to Well 37-88BR, information on vertical hydraulic gradients can be obtained.
- Well D-88 -- Located just north and downgradient of the oil burn pit (SWMU 153). Currently, no wells are located downgradient of this probable contaminant source area.
- Well E-88 -- Located in SWMU 154 (pallet burn site). This well will provide source characterization data for this SWMU, and help complete potentiometric maps for the alluvial groundwater system.
- Well F-88 -- Located 50 ft north of Borehole 20-87BR. This well will provide water quality data immediately downgradient of the Mound area.

East Trenches Area--

- Wells G-88 and H-88 -- These two wells should be located next to 47-88BR, converting this location to a three (or two) well cluster. One well should be screened at the water table, and the other at the alluvium/bedrock contact. This cluster will provide source characterization and vertical migration data for Trenches T-4 and T-11.
- Well I-88 -- This well will be located 25 ft west of the southeast corner of Trench T-10 to monitor downgradient water quality. Currently, no wells are located to the south (downgradient) of Trench T-10.
- Well J-88 -- Located halfway between Well 40-88 and Well 46-88. This well will provide alluvial groundwater quality data immediately north of SWMU 110 (Trench T-3).
- Well K-88 -- Located 50 ft east of Borehole 39-87. This well will provide alluvial groundwater quality data south of SWMU 110 (Trench T-3), and provide important potentiometric data in this area.
- Well L-88 -- Located 25 ft southwest of Borehole 46-87. This well will provide alluvial groundwater quality data south of SWMU 111.7 (Trench T-10).
- Well M-88 -- Located next to alluvial Well 65-88 and bedrock Well 64-88BR. Well M-88 should be completed at the alluvium/bedrock contact, assuming that Well 65-88 will be completed at the water table in the alluvial aquifer.
- Well N-88 -- This well will be located next to Well 60-88BR (also proposed for relocation). In conjunction with Well 60-88BR, Well N-88 will monitor water quality down-

gradient of Trench T-9 (SWMU 111.6), and provide vertical hydraulic gradient information.

- Well O-88 -- This well will be located next to Well 69-88BR (also proposed for relocation). In conjunction with Well 69-88BR, Well O-88 will monitor alluvial groundwater quality downgradient of Trenches T-5, T-6, and T-7 (SWMUs 111.2-111.4), and provide vertical gradient information.
- Cluster C4-88 -- This cluster will be located 50 ft east of Borehole 52-87, directly downgradient of Trenches T-5, T-6, and T-7. There are currently no existing or proposed wells in this area. The bedrock well should be completed in sandstone P.
- Cluster C5-88 -- This cluster will be located next to Borehole 55-87 to determine if contaminants detected in the soils at this location have reached the groundwater north of Trench T-5. The bedrock well should be completed in sandstone P.

Bedrock Monitoring Well Placement

Previous investigations into the bedrock aquifer system have revealed the presence of numerous saturated sandstone beds within the claystones of the Arapahoe Formation. The Arapahoe Formation directly underlies the unconsolidated alluvium at the site. Previous studies have found that these two systems are hydraulically interconnected, and that a strong downward-directed vertical gradient exists between groundwater in the alluvium and the groundwater in the bedrock. Contaminants, including volatile organic compounds, have been detected in several of the saturated sandstone beds, necessitating an evaluation of the nature and extent of the bedrock groundwater contamination.

The hydrogeology of the bedrock aquifer system is poorly understood. For example, no potentiometric surface maps are presented for the bedrock

aquifer in previous reports. A basic understanding of the geometry of the groundwater flow path(s) in the bedrock aquifer has not been established. A limited number of hydraulic conductivity tests have been performed for some of the sandstone units. Hydraulic conductivity tests should be performed in wells screened adjacent to the weathered bedrock horizon and the sandstone beds of the Arapahoe Formation. The nature and extent of contamination in the bedrock aquifer is also poorly defined. Only three bedrock wells are located within 50 ft of any of the potential contaminant sources. There are virtually no bedrock wells located in a large area between the 903 Pad and the East Trenches areas (Figure 3).

The continuity of the sandstone beds is also poorly understood. Sandstone beds have been correlated "based on similar lithologies in relatively closely spaced wells," and have also been described as "lenticular and somewhat discontinuous." Plates 2-5 through 2-8 of the Phase II RI plan provide cross-sections of the sandstones encountered in boreholes. It is apparent that many of the sandstone units are sub-horizontally bedded, and eventually subcrop beneath the unconsolidated overburden. Some sandstone units have been represented as discontinuous on the bedrock cross-sections and maps, without well or borehole information to confirm the lack of horizontal continuity shown on the cross-sections.

The primary data gaps for the bedrock aquifer system are:

- Definition of the continuity and lateral extent of sandstone subcrop units
- Potentiometric surface data
- Areal distribution gaps between existing (and proposed) monitoring well locations
- Lack of bedrock monitoring wells proximal to potential contaminant sources in the 903 Pad and East Trenches areas.

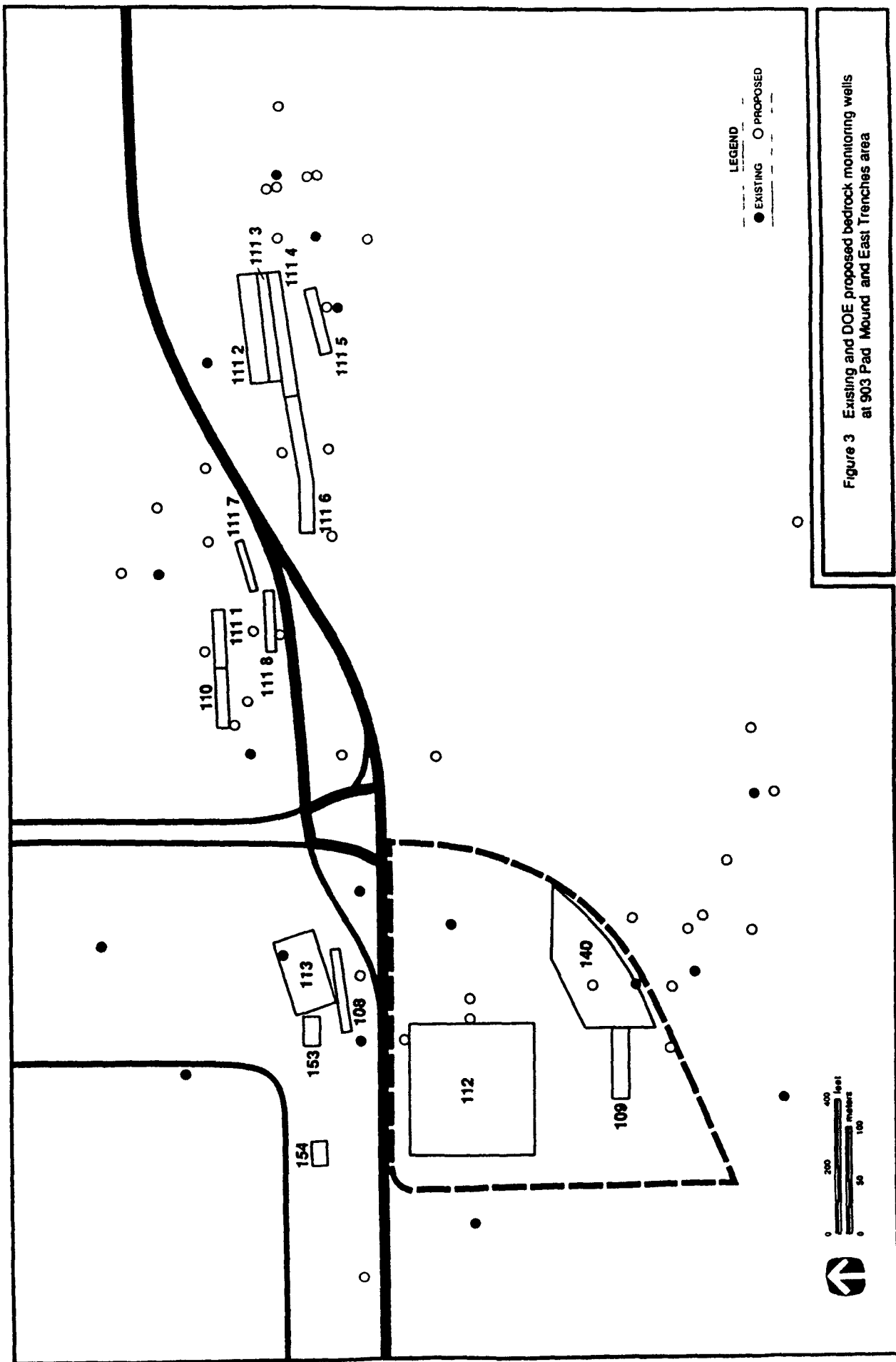


Figure 3 Existing and DOE proposed bedrock monitoring wells at 903 Pad Mound and East Trenches area

A basic understanding of the hydrogeology of the bedrock aquifer system, and consequently, the nature and extent of contamination in this system, has not yet been established. Before potentiometric, contaminant plume, and source characterization data for the bedrock aquifer can be evaluated, a better correlation between the sandstone subcrops must be established. Many of the bedrock wells proposed in the Phase II RI plan are located to provide information concerning the continuity, extent, and orientation of the sandstone interbeds. Monitoring well placements are generally not warranted as a primary method for correlation of sandstone subcrops. Boreholes can be used to correlate sandstone interbeds at a lower cost and with greater efficiency than is required to complete monitoring wells. New monitoring wells should be aerally distributed to obtain representative potentiometric surface data, define the nature and extent of contamination, and to provide additional information on sandstone correlations from the accompanying borehole data

In addition, basing correlation of a sandstone on "similar lithologies in relatively closely spaced wells" may not always be accurate. A sandstone may change character, laterally or vertically, over relatively short distances. A potentially accurate method of sandstone correlation would be to use existing monitoring well and borehole locations to perform borehole geophysics (i.e gamma logs). Borehole geophysics is a reliable, relatively inexpensive, and efficient means of correlating subsurface geologic units. Borehole geophysical data would also help verify and add confidence to existing sandstone correlations.

Review of Proposed Bedrock Monitoring Wells

The majority of the proposed bedrock monitoring well locations are sufficient to provide additional hydrogeologic and contaminant transport data for the bedrock aquifer. The following section recommends establishment of some proposed bedrock wells at other locations to provide better areal distribution of the bedrock monitoring well network. Improved areal distribution of bedrock monitoring wells will:

- Provide better site-wide information on sandstone interbeds
- Remove the large spatial gaps in the existing system
- Provide better site-wide potentiometric surface data
- Better define the nature and extent of contamination in the bedrock aquifer.

The following is a list of proposed bedrock wells (see Figure 2) recommended for relocation together with the rationale for relocation:

- Well 37-88BR -- Move approximately 50 ft north. This well should be adjacent to Trench T-1 and a proposed alluvial well. This new location will provide source characterization downgradient of Trench T-1. The original location appears to be too far downgradient of Trench T-1 to provide adequate data on bedrock contamination in the vicinity of Trench T-1.
- Well 80-88BR -- Move 200 ft southwest. This new location will provide better areal distribution of wells completed in sandstone R, and provide downgradient water quality data for Trench T-4. The original location is too far downgradient (250 ft) of Trench T-4, and too close to Well 36-87BR.
- Well 60-88BR -- Move approximately 50 ft north. The new location is adjacent to Trench T-9 and a proposed alluvial well. This new location will provide downgradient water quality data for Trench T-9. The original location appears to be too far downgradient of Trench T-9, and may have been placed south of the paleochannel, which may influence contaminant migration.
- Well 69-88BR -- Move approximately 100 ft northwest. The new location is adjacent to the southeast corner of Trench T-7,

and a proposed alluvial well. This new location will provide downgradient water quality data for Trench T-7. The original location appears to be too far downgradient of Trench T-7.

- Well 67-88BR -- Move 100 ft south. This new location will provide a better areal distribution of wells completed in sandstone P and help define the contaminant plume in this sandstone. The original location is too close to proposed Well 68-88BR, which monitors the next deepest sandstone (sandstone N).
- Well 81-88BR -- Move 200 ft north. This new location will monitor downgradient groundwater quality in sandstone M (near the northeast corner of Trench T-5), and provide a better areal distribution of wells in this area. The original location is too close to Well 40-86BR.
- Well 70-88BR -- Move 300 ft northwest. This new location will monitor downgradient groundwater quality in sandstone O (near Trench T-5), and provide a better areal distribution of wells in this area. The original location is too close to Well 40-86, which monitors the next deepest sandstone (sandstone P).

Four recommended bedrock well additions focus on removing large spatial gaps in the bedrock monitoring well network. Recommended additions to the bedrock monitoring well system are presented below:

- Well P-88BR -- Located 100 ft east of the northeast corner of the reactive metal destruction site. This bedrock monitoring well should be completed in sandstone V or W.
- Well Q-88BR -- Located 150 ft southeast of existing Well 16-87BR. This bedrock monitoring well should be completed in sandstone X or Y.

- Well R-88BR -- Located exactly halfway between proposed Well 33-88 and proposed Well 51-88. This bedrock monitoring well should be completed in sandstone R or S.
- Well S-88BR -- Located 100 ft northeast of the southeast corner of the Mound. This bedrock monitoring well should be completed in sandstone X or Y.

SURFACE SOIL SAMPLING

The surface soil sampling program outlined in the Phase II RI plan should provide the necessary information concerning the aerial extent of radionuclides in surface soils outside of the SWMUs. The sampling strategy proposed to define the vertical distribution of plutonium in surface soils is acceptable, except that areas which have been covered with fill are not addressed. Fill covered areas should be clearly delineated on a site map together with proposed sampling locations. Some adjustment to the proposed sampling strategy will need to be made to define plutonium concentrations in current ground surfaces, fill areas, historic ground surfaces, and in soil beneath ground surfaces.

The most obvious data gap in the surface soil sampling portion of the Phase II RI plan is the absence of source characterization within the SWMUs. The plan should be rewritten to address filled and capped areas, the vertical distribution of radionuclides, and historic ground surfaces.

The surface soil sampling portion of the plan does not address all contaminants of concern, and therefore will not provide sufficient data to support a risk assessment. At a minimum, americium, uranium, and thorium (previously identified as contaminants of concern) should be added to the analytes for surface soil sampling analyses.

SURFACE WATER AND SEDIMENT SAMPLING

The proposed surface water and sediment sampling program is generally adequate with the following exceptions

- There does not appear to be any sediment, or water samples collected from the B- or C-series ponds. These ponds are potential migration pathways, and should be evaluated in conjunction with the 903 Pad area.
- There does not appear to be any sediment, or water samples downstream in Walnut Creek. Again, this is a likely migration pathway, and should be monitored.
- The Phase II RI plan should specify the frequency of surface water and sediment sampling, and whether or not storm events will be monitored.
- Based on the results of the Phase I RI, it appears that limiting the sampling effort to locations west of Indiana Street is not warranted. If offsite sampling of surface water and sediments is being performed under a separate program, then it should be referenced in the Phase II RI plan.

SECTION 5 0 METHODS

FIELD METHODS

Many of the procedures for the field activities outlined in the Phase II RI plan are referenced to standard operating procedures (SOPs). These SOPs are contained in the Draft Project Operations Plan - Geological and Hydrological Site Characterization (Rockwell International 1986). As part of the review of the Phase II RI plan, the SOPs were briefly reviewed. Several inconsistencies and deficiencies were noted including:

- The grout used to backfill wells and boreholes is stated to be Type I or Type II Portland cement. Grouts used for this purpose must contain at least 5 percent by weight bentonite. Alternatively, a pre-mixed grout containing bentonite (e.g., VolclayTM) may be used.
- The SOPs state that geologic cores and analytical samples can be collected using auger or rotary drill cuttings. This practice is completely unacceptable for the collection of analytical samples, especially with regard to volatile and semivolatile analyses.
- The SOPs state that during well purging, water will be pumped from the bottom of the well. This method will leave stagnant water in the well. An acceptable method of well purging is to start pumping from the top of the water column and lower the pump as the water level falls. This method ensures complete evacuation of all stagnant water from the well.
- The SOPs state that all bottles used for groundwater sampling should be rinsed with formation water before sample collection. This procedure can bias samples (U.S. EPA 1986) and

should not be used. Sample bottles are precleaned under controlled laboratory conditions, and rinsing is not necessary.

It appears that these SOPs contain errors and, in some cases, have become outdated in the 2 yr since they were written. SOPs should be developed that use new guidance, and that are designed for the Phase II field effort. For a project of this size, it is important to have all field methods incorporated into the sampling plan, either directly in the text or attached as appendices so that the document will be "field ready."

Other deficiencies noted in the Phase II RI plan include:

- It must be clearly stated that soil samples will be collected from all boreholes, including those in which monitoring wells are to be completed.
- The methods used to collect soil samples must be clearly stated. The Phase II RI plan states that samples will be collected every 2 ft, composited over the 2-ft interval, and every other sample will be submitted for analysis. Samples for volatile organic analysis must be collected before the samples are composited (i.e., grab samples). All cores should be screened with a photoionization detector and a radiation meter immediately after collection to detect high levels of volatile organics or radionuclides. If screening indicates that high contaminant levels exist, then samples from that core should be submitted for analysis. At least one sample every 5 ft should be submitted for analysis.
- All new monitoring wells should include a sump (minimum 6 in long) beneath the screened interval. A sump would serve two functions: prevent the screen from becoming silted, and provide a place for the collection and sampling of dense phase contaminants.

- All new monitoring wells should be equipped with two centralizers; one located on the sump immediately beneath the screen, and one located immediately above the screen but below the bentonite seal to prevent bridging. Centralizers are not mentioned in the Phase II RI plan
- When backfilling boreholes prior to well installation, sand should be used as the backfill material beneath the sump. This would minimize potential interaction between bentonite and groundwater contaminants. If the borehole is drilled to a level beyond the bottom of the well, then bentonite can be used as backfill up to 2 ft below the bottom of the sump.
- The bentonite seal placed above the sandpack in alluvial wells should be at least 2 ft thick (U.S. EPA 1986). The proposed seal thickness of 0.5 ft is inadequate to isolate grout from the sandpack and screened interval. Seals should be emplaced with a tremie pipe, hydrated (if necessary), and tamped into place to create a 2-ft thick (minimum) seal.
- The grout placed above the bentonite seal should contain at least 5 percent by weight bentonite (preferably 10 percent) to ensure the grout will swell when setting. The neat cement grout proposed in the Phase II RI plan will shrink when setting, and will not ensure the necessary seal. All grouts used to abandon boreholes or seal well annuli should contain at least 5 percent by weight bentonite, be emplaced under pressure using a tremie pipe, and have a minimum density of 10 lb/gal. Grout density should be verified using a mud-cup test.
- The size of the hollow stem auger to be used during well installation should be specified. For 4-in diameter wells, a 6-in inside diameter auger should be used. Also, the borehole should be of sufficient diameter to install a minimum 3-in annular sandpack (i.e., 10 in for a 4-in well)

For the deep bedrock wells, the rotary drilled section of the borehole must be at least a 8-in diameter.

- Criteria must be established for well purging and development that define when wells should be completely purged or developed. Such criteria should include stabilization of conductivity and pH readings (for purging and well development), and the generation of "clear" formation water (for well development).
- For well development, surging should always be used in combination with bailing or gaslift methods. The gas used to evacuate wells should be inert (e.g., nitrogen) so the formation does not become oxidized during well development. All downhole development and purging equipment, including pumps, should be fully decontaminated between wells to prevent cross-contamination.
- There should be a minimum 3-wk equilibration period following well development prior to the sampling of new wells.

It is critical that the sampling and analysis plan for the Phase II RI is a stand-alone document capable of providing field personnel with all necessary guidance to perform the fieldwork in a manner that satisfies all quality assurance/quality control (QA/QC) requirements.

LABORATORY METHODS AND DATA ANALYSIS

The Phase II RI plan briefly addresses the analytical program to be used throughout the Phase II RI. Tables 5-1, 5-2, and 5-3 list the analytical parameters for soil, groundwater, and surface water samples respectively. Some inconsistencies were found in these tables including:

- Strontium (metallic or radiometric) is not listed as an analyte in Table 5-1 for soil samples, but it is listed for both groundwater and surface water samples. This deletion is

not consistent, and is puzzling given the results of the Phase I RI, in which strontium was detected at high levels in soil samples from several boreholes

- Semivolatile organics are not analyzed in soil or water samples. This is not consistent with the results of the Phase I RI, in which phthalates were detected in all soil samples, and are known to be a constituent of wastes disposed of in the project area. For Phase II of the RI, analysis of a limited suite of semivolatiles, including all of the phthalates, is still warranted for both soil and water samples.
- Samples for volatile organics should be preserved with concentrated hydrochloric acid to pH 2 or less. This is especially critical for substituted aromatics (e.g., xylene, styrene) and 1,1,2,2-tetrachloroethane, which will decay if not preserved.
- The analytical equipment (e.g., gas chromatograph and mass spectrometer) must be free from salt contamination which may be introduced during the analysis of previous analytical batches. Salts in the tubing of instruments can degrade chlorinated organic compounds.
- Groundwater samples should be analyzed for total recoverable hazardous substance list metals (i.e., unfiltered) for comparison with U.S. EPA ARARs such as Safe Drinking Water Act MCLs. Filtered samples for ion (anions and cations) and metals analysis are also recommended to define transport phenomena such as adsorption, and to evaluate aquifer continuity. Unfiltered radionuclide samples are also required for comparison to ARARs.
- The Phase II RI plan states that all samples will be analyzed following U.S. EPA Contract Laboratory Program (CLP)

protocols This statement is adequate for all compounds for which CLP protocols exist The following compounds do not have CLP protocols. lithium, tin, strontium (metallic or radiometric), major ions, oil and grease, and radionuclides U S EPA approved methods or other adequate protocols must be presented for these compounds.

All data generated from the analysis of samples collected during this and all subsequent phases of site characterization must be presented without pre-screening This includes presentation of raw analytical data, all QA/QC results and data, and results of all statistical tests In previous reports (e g., Phase I RI plan for 903 Pad, 881 Hillside areas), data were only presented for compounds that were detected, instead of for all compounds and their associated concentrations or detection limits.

DATA ANALYSIS AND VALIDATION METHODS

The Phase II RI plan presents five criteria on page 5-18 that are used to judge data acceptability. The first four criteria are adequate only if implemented correctly. The last criteria, stated simply as "conceptual validity," is totally inconsistent with accepted data validation techniques. The "conceptual validity" criteria for acceptance of data is based on the results of a statistical test (Dixon's Test) to determine outliers in a data set (Dixon 1950). An outlier is defined in the Phase II RI plan as " . an extreme observation that does not conform to the pattern established by other observations." Furthermore, "...outliers are minimized by strict adherence to the QA/QC (quality assurance/quality control) and Technical Data Management (TDM) Plans." According to the Phase II RI plan, a datum that is considered to be an outlier, for which no cause for its extreme value can be assigned through the QA/QC and TDM plans, would be analyzed by Dixon's Test for acceptance to the conceptual model of the site. However, the use of statistical tests to determine whether or not to ignore certain sampling data is highly questionable, for reasons outlined below.

The use of statistical tests to analyze a set of data that are representative of a given population depends on both the proper definition of the

data and the identification of the population that was sampled. The definition of an "outlier" datum as presented in the Phase II RI plan is not entirely accurate. An outlier is more specifically defined as a value that lies outside Region $x \pm 4s$ (Sachs 1984), where "s" is the standard deviation of the sample data. This region includes 99.99 percent of the values for a normal distribution, and 94 percent of the values for an arbitrary distribution of data. Only under certain conditions of measurement errors, judgement errors, execution faults, and computational errors can an "outlier," as defined above, be neglected from a data set (Sachs 1984). According to the Phase II RI plan, these errors should be mitigated by adherence to the QA/QC Plan.

After elimination of these sources of extreme data, according to Sachs (1984), the presence of statistical outliers may be an indication of natural variability, weaknesses in the model, or weaknesses in the data. Since one of the uses of statistical tests for outliers is to recognize extreme data that may be important (Dixon 1950), natural variability in sampling data should be given priority as a source of extreme values. Furthermore, statistical tests for outliers are useful in determining whether or not extreme data belong to a population other than the one the remaining values belong to (Dixon 1950). This discussion is particularly applicable to the analysis of data from groundwater wells and soil boreholes from contaminated sites that may contain a number of known and unknown sources of contaminants. In this situation, extreme values may in fact represent different "populations" (i.e., contaminant sources or plumes that are different from those to which the remaining values belong). Under this consideration, extreme values should be analyzed as representative of sources that may be inadequately accounted for in the conceptual model. These data can then be used to update and refine the model, as suggested in the Phase II RI plan, and as emphasized by Dixon (1950).

Based on the above discussion, the final conclusion of the Phase II RI plan (that sampling data, identified by Dixon's Test as outliers, be eliminated from further review) should be deleted. Such sampling data should instead be used to modify the existing conceptual model of the site. These data should also be considered during the quantitative assessment of

potential human health risks at the site To restate this point, the validity of data should not be based on how well it fits into the accepted conceptual model If data contradict a model, then the model should be modified rather than assuming the data are invalid

Additionally, the citation in the text for the U.S. EPA document on standard CLP protocols (page 5-20) does not match the listing in "6.0 References" An updated version of this document is now available (U.S. EPA 1988) and should be cited and utilized instead of the 1985 version.

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